COLOR IMAGE CONTRAST ENHANCEMENT BASED ON NON-REGULAR REGIONS SELECTING

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Abstract

The enhancing of the contrast of whole image doesn`t gives us the optimization solution for enhancing the contrast of an interested region in the image. However, in this paper the Automatic Extracted Object Contrast Enhancement (AEOCE) technique proposed. The proposed system is devided into two parts: the first part is interested in the extraction process of the interested region from the original image. While the second part of it is interested of enhancing the contrast of the subimage. There are many techniques are used to extract the interested region such as thresholding, smoothing, boundary extraction…etc. while techniques such as Gray level grouping (GLG) method, autocontrast enhancement method …etc are used to enhance the subimage automatically.

1. Introduction

The image processing fields become more and more important in our life. There are many branches in this field such as :- cryptography, steganography, image enhancement … etc.[1-5]. The purpose of an image contrast enhancement methods is to increase image visibility and details. Numerous enhancement methods have been proposed in the literature such as histogram processing methods [6-8] , graylevel compression and stretching using exponentials and polynomials [6, 7], spatial statistical filtering [9], and frequency domain processing techniques [10]… etc. The image enhancement methods can be considered by many common factors such as enhancement efficiency, computational requirements, application suitability…etc.

Contrast enhancement techniques can be classified into three types which are manual techniques, adaptive techniques and automatic techniques.

Automatic techniques give us an optimal level of contrast enhancement automatically depending on some conditions without addition information. Histogram equalization, Gray level grouping… etc are many techniques which enhanced image contrast automatically [6, 11, 12].

The AEOCE technique will be proposed to enhance the contrast of the interested subimage automatically after extract it from the original image. The technique divided into two major parts: object extraction and object contrast enhancement parts.

2. Global automatic image enhancement technique

Contrast enhancement techniques had a wide area of importance because of the importance of making the image more suitable to visualize and to improve the details in the image. Some of techniques that very powerful in a state not a suitable in other state depending on the input image. There are many techniques that are enhancing the contrast of the image automatically, like:

2.1 Histogram equalization

This is a very well known technique that used to enhance the contrast of the image. This technique tries to redistribute the gray level uniformly on the gray scale [6]. In principle, the histogram equalization method increases the contrast of the image by transforming its histogram into a uniform one that spans the full graylevel range. This is based on the assumption that for maximum transfer of information, the perceived distribution (histogram) of graylevels in an image should be uniform. It can be easily shown that the for discrete 8-bit grayscale images, the HE method achieves this by using the transformation function [0, 255]

$$s = T(r) = 255x\sum_{w=0}^{r} h_i(w)dw = 255xCDF(r) \ , \qquad r \in [0,255] \quad (1)$$

Which is simply the cumulative distribution function *CDF(r)* of the normalized original image histogram *hi(r)* [6, 7, 11].

2.2 Histogram stretching

This technique is used to stretch the histogram of the image along the gray scale. The histogram of the image can be modified by a mapping function, which will stretch the histogram of the image. The mapping function of this technique is

$$J = \left[\frac{I-I_{min}}{I_{max}-I_{min}}\right][MAX - MIN] + MIN \ \ .... (2)$$

Where I_{min} is the smallest gray level value, I_{max} is the largest gray level value, MAX and MIN is the maximum and minimum gray level values possible (for 8-bit image these values are 0 and 255)[6].

2.3 Autocontrast technique

One of the newest techniques that used for image contrast enhancement is autocontrast techniques, which is an automatic technique. The core idea of this technique is to redistribute the image histogram on the gray scale by using the flowing mapping equation

$$J = MAX \times \frac{I - I_{MIN}}{I_{MAX} - I_{MIN}} \ \ ... (3)$$

Where I is the inpu0t image, I_{MIN} is the minimum gray level of the input image, I_{MAX} is the maximum gray level of the input image, and MAX represent the maximum gray level value (MAX=255 for an 8 bit image).[15,16]

2.4 Gray level grouping (GLG)

GLG Is one of the newest techniques to enhance the contrast of the image. It is a fully automatic technique so it gives us the optimal level of contrast enhancement. The basic procedure was grouped the histogram components of a low-contrast image into a proper number of bins according to a selected criterion, then redistributed these bins uniformly over the grayscale, and finally ungrouped the previously grouped[12].

The algorithm of this technique is described as follow

i.assigned the non-zero component in the original histogram

$$G_n(i) = H_n(\text{k}) \ \text{ for } \ \text{H}_\text{n}(\text{k}) \neq 0 \qquad .....(4)$$
$$k = 0,1,2 \ldots \ldots, M-1 \ \ ; \ \ i = 1,2,3 \ldots \ldots, n$$

ii. Record the left and right limit, L (i) and R (i), of the gray-level interval represented by $G_n(i)$

$$L_n(i) = R_n(i) = k \quad \text{for } H_n(k) \neq 0$$
$$k = 0,1,2 \ldots \ldots, M-1 \; ; \; i = 1,2,3 \ldots \ldots, n \quad \ldots(5)$$

iii.The first occurring smallest $G_n(i)$ is found where

$$a = \min_i G_n(i) \quad \ldots\ldots(6)$$

and i_a is the group index corresponding to the smallest $G_n(i)$

iv. Now group the $G_n(i_a)$ is merged with the smaller of its two adjacent neighbors, and the gray-level bins $G_n(i)$ are adjusted to create a new set of bins $G_{n-1}(i)$, as follows

$$G_{n-1}(i) = \begin{cases} G_n(i) & \text{for } i = 1,2,3 \ldots\ldots, í-1 \\ a+b & \text{for } i = í \\ G_n(i+1) & \text{for } i = í+1, í+2 \ldots, n-1 \end{cases} \quad \ldots\ldots\ldots (7)$$

Where

$$b = \min \{G_n(i_a - 1), G_n(i_a + 1)\} \quad \ldots\ldots\ldots (7a)$$

and

$$í = \begin{cases} i_a - 1 & \text{for } G_n(i_a - 1) \leq G_n(i_a + 1) \\ i_a & \text{otherwise} \end{cases} \quad \ldots\ldots\ldots (7b)$$

$$L_{n-1}(i) = \begin{cases} L_n(i) & \text{for } i = 1,2,3 \ldots\ldots, í \\ L_n(i+1) & \text{for } i = í+1, í+2 \ldots, n-1 \end{cases} \quad \ldots\ldots\ldots (7c)$$

$$R_{n-1}(i) = \begin{cases} R_n(i) & \text{for } i = 1,2,3 \ldots\ldots, í-1 \\ R_n(i+1) & \text{for } i = í, í+1 \ldots, n-1 \end{cases}$$

v.Calculate the number of gray levels, N_{n-1}, that each gray-level bin will occupy in the resulting image.

$$N_{n-1} = \frac{M-1}{n-1}. \quad \ldots\ldots (8)$$

Where n-1 is the total number of bins.
To prevent that component from occupying too many gray levels let

$$N_{n-1} = \frac{M-1}{n-1-\alpha} \quad \ldots\ldots(8a)$$

Where α is a constant between (0-1).

vi.There are four cases to construct the transformation function $T_{n-1}(k)$ as follows:

If $L_{n-1}(i) \neq R_{n-1}(i)$ and the gray level k falls inside gray-level bin $G_{n-1}(i)$, there are two ways to construct the transformation function depending on both $L_{n-1}(1)$ and $R_{n-1}(1)$

$$T_{n-1}(k) = \begin{cases} \left(i - \alpha - \frac{R_{n-1}(i)-k}{R_{n-1}(i)-L_{n-1}(i)}\right) N_{n-1} + 1, & \text{for } L_{n-1}(1) = R_{n-1}(1) \\ \left(i - \frac{R_{n-1}(i)-k}{R_{n-1}(i)-L_{n-1}(i)}\right) N_{n-1} + 1, & \text{for } L_{n-1}(1) \neq R_{n-1}(1) \end{cases} \quad \ldots\ldots\ldots (9)$$

If $L_{n-1}(i)=R_{n-1}(i)$ or the gray level k fill between $G_{n-1}(i)$ and $G_{n-1}(i+1)$, then there are two ways to construct the transformation function depending on both $L_{n-1}(1)$ and $R_{n-1}(1)$

$$T_{n-1}(k)=\begin{cases}(i-\alpha)N_{n-1}, & \text{for } L_{n-1}(1)=R_{n-1}(1)\\ iN_{n-1}, & \text{for } L_{n-1}(1)\neq R_{n-1}(1)\end{cases} \quad \dots (10)$$

If k equal or larger than $R_{n-1}(n-1)$, then the transformation function will be

$$T_{n-1}(k)=M-1 \quad \dots\dots\dots (11)$$

If k less or equal than $L_{n-1}(1)$, then the transformation function will be

$$T_{n-1}(k)=0 \quad \dots\dots\dots (12)$$

3. The Proposed AEOCE Technique

The proposed AEOCE technique consist of two major pats: object extraction and Object contrast enhancement parts. Object extraction part this is the first essential part in our technique. For color (RGB) images, the second type of the extraction subsystem must be applied to each band (red, green and blue) separately, and then the result of the three bands is reconstructed to form the final subimage. Figure (1) shows color image non-uniform extraction.

Extraction subsystem can be explained as shown in figure (2)

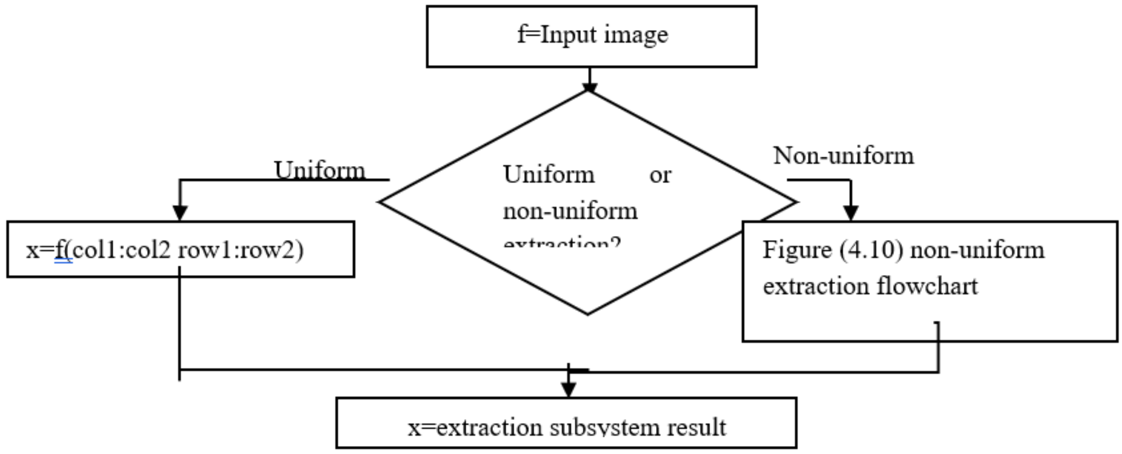


Figure (1) Extraction subsystem flowchart

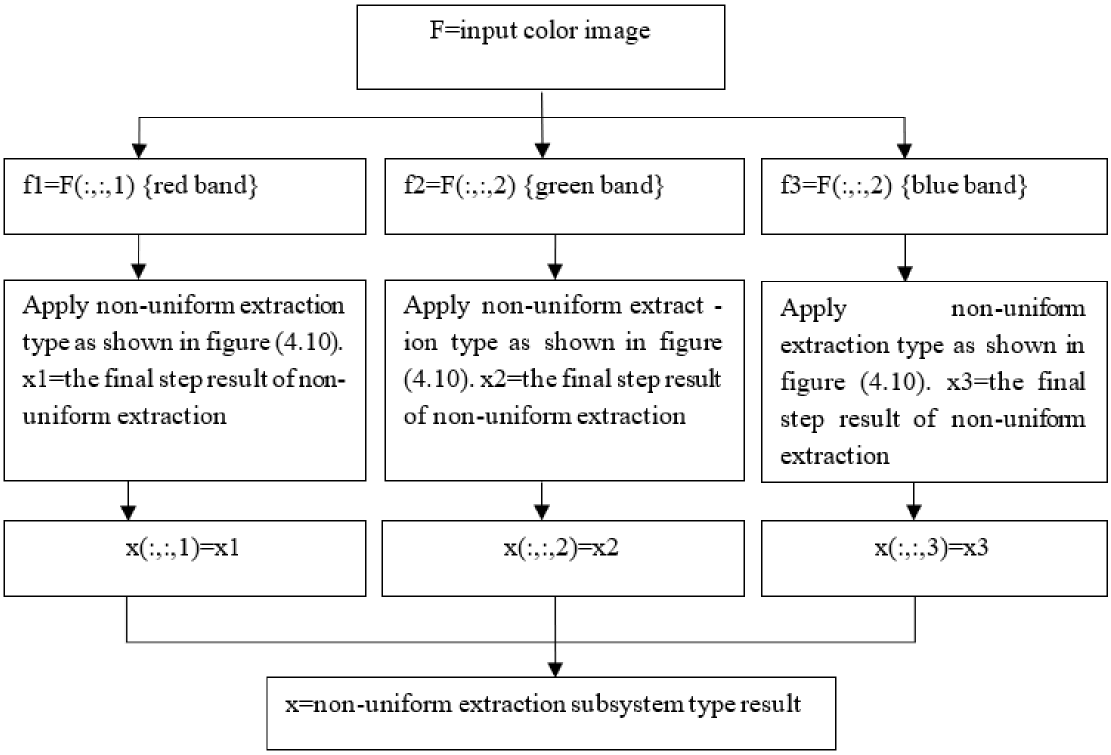


Figure (2) Non-uniform extraction subsystem for color images

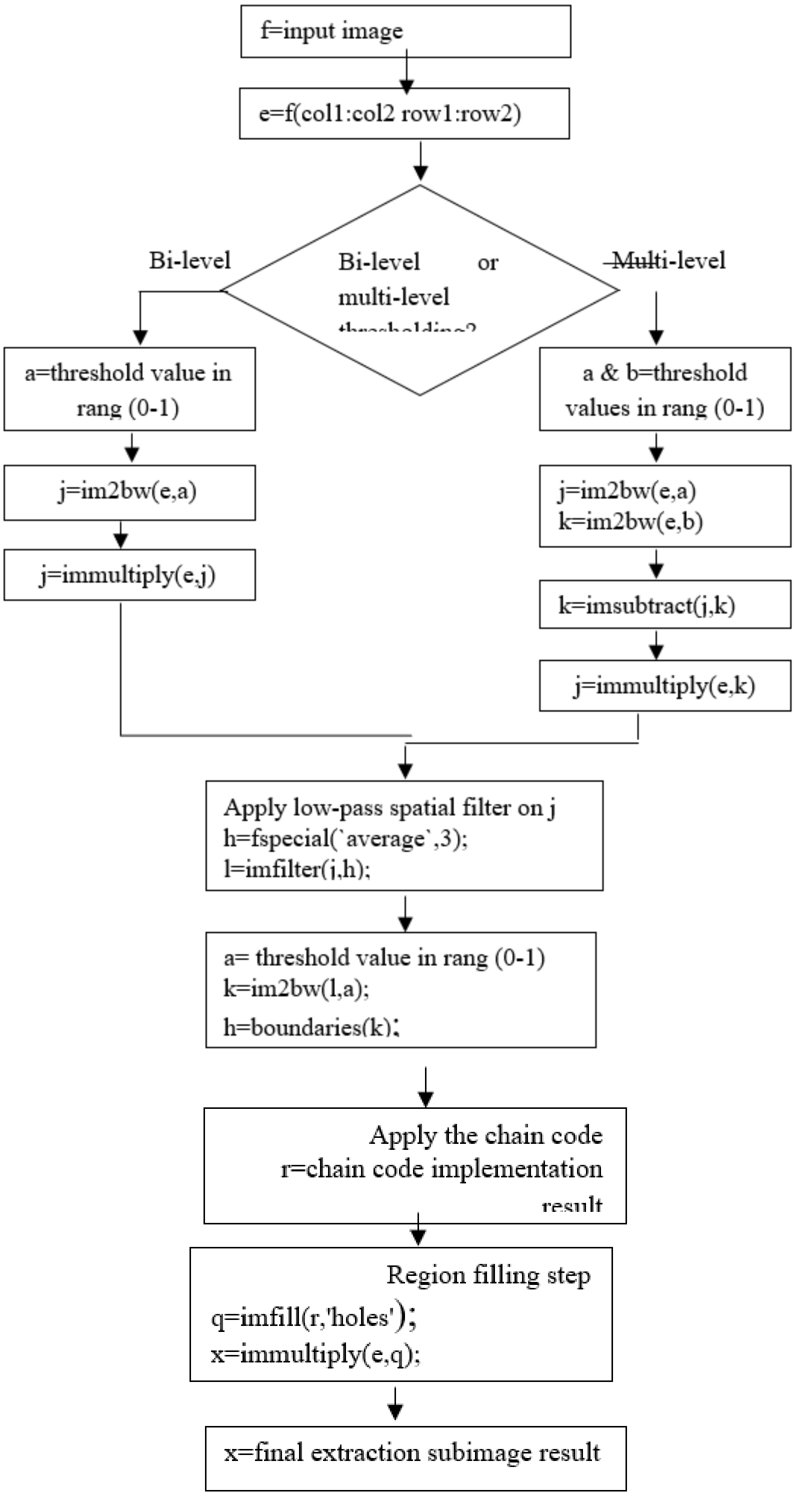
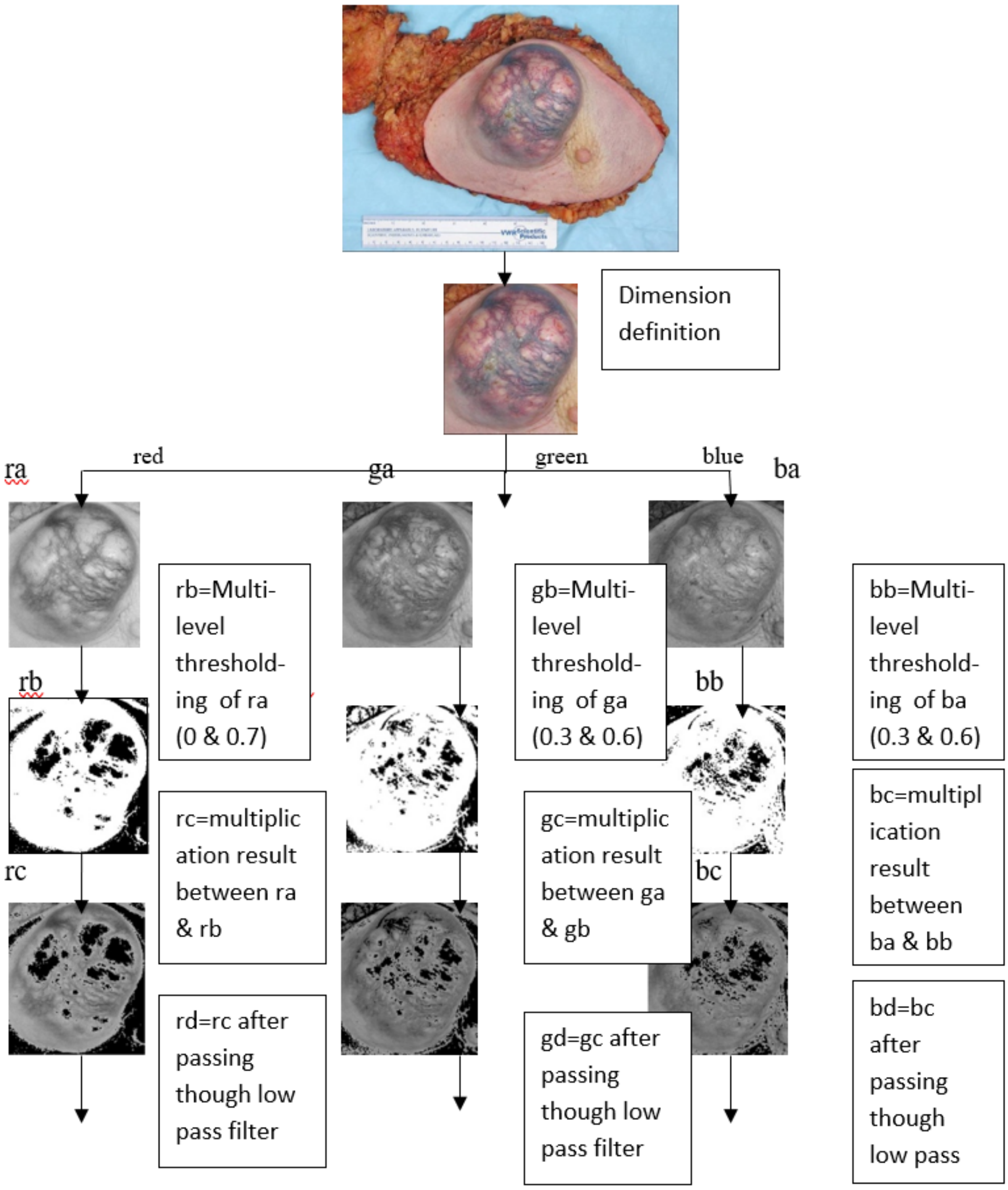


Figure (3) non-uniform extraction subsystem flowchart

Figure (4) shows how the non-uniform extraction has been applied on a color (RGB) medical image.


Dimension definition
red
green
blue
ra
ga
ba
rb
bb
rc
bc
rb=Multi-level threshold-ing of ra (0 & 0.7)
gb=Multi-level threshold-ing of ga (0.3 & 0.6)
bb=Multi-level threshold-ing of ba (0.3 & 0.6)
rc=multiplication result between ra & rb
gc=multiplication result between ga & gb
bc=multiplication result between ba & bb
rd=rc after passing though low pass filter
gd=gc after passing though low pass filter
bd=bc after passing though low pass

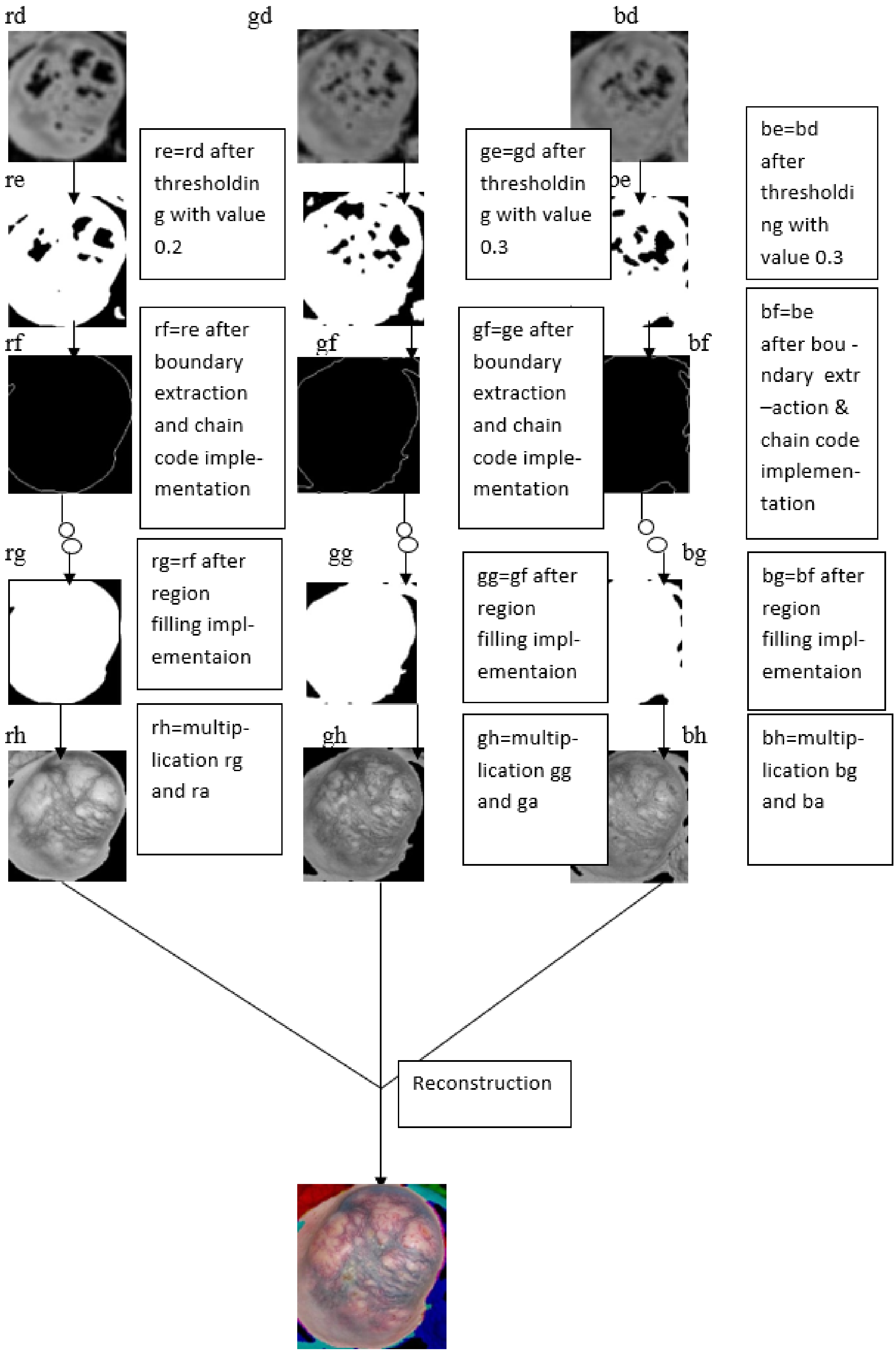


Figure (4) Non-uniform extraction for color (RGB) image

Figure (4) shows the results of applied our technique on the image. Where, figure (3) shows the original image after applying the AEOCE technique. While figure (5) shows the effect of enhancing the contrast of the whole image on the interested region in the image. It is very clear how many details are appeared when applying the AEOCE technique on the image. Figure 5 shows the result of contrast enhancement implementations , while figure 6 shows the difference between the implementation of the enhancement techniques on the image compared with the proposed system implementation.

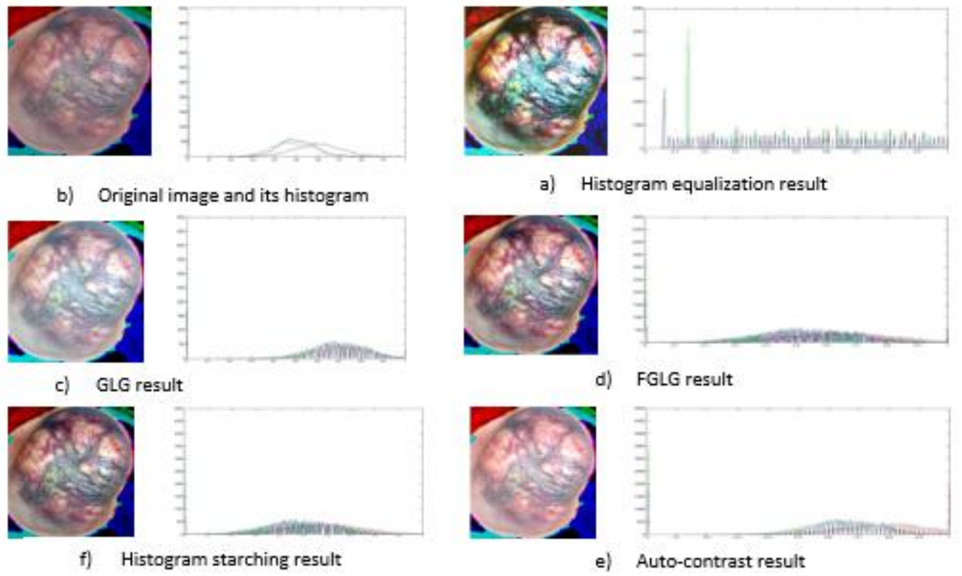


Figure 5 the proposed system results

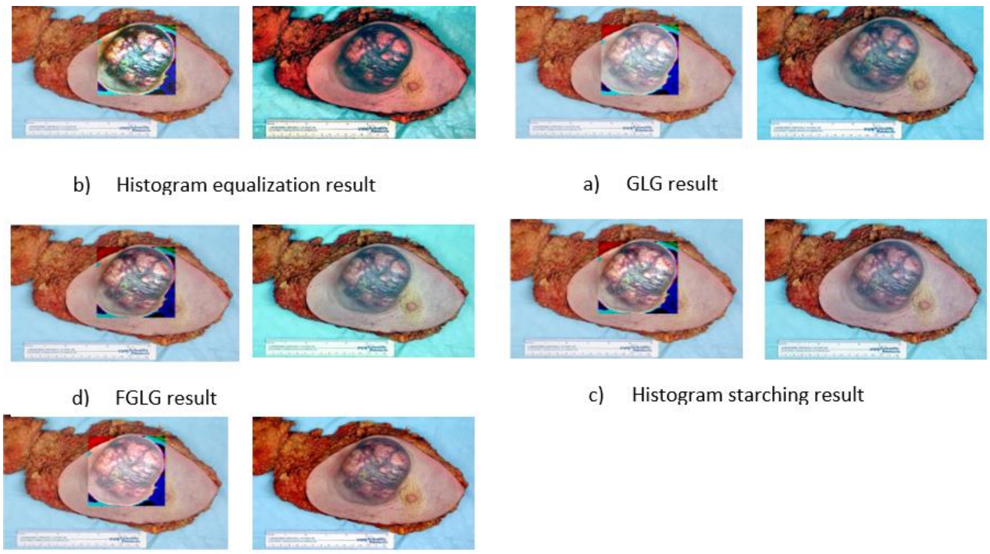


Figure 6 comparison between the proposed system results and the result of the full image implementation

The system consisting of a combination of techniques for enhancing the contrast of an interested region in the medical image, was proposed. From the results shown of the proposed system, we found that Resultant images from Histogram equalization implementation have a high standard deviation. But the image appearance and the redistribution of the image histogram make the resultant images unacceptable for both grayscale and color images.while the Resultant images from gray level grouping, FGLG and histogram stretching implementation have a high standard deviation. The image appearance and the redistribution of the image histogram make the resultant images acceptable for both grayscale and color images and contrast enhancement results of this work are better than the global contrast enhancement of the same image when using the same techniques for an interested region in the image.

5. References

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NOMENCLATURE:-

AF	High-boost spatial filter amplification factor
α	Gamma correction constant
B	Morphological operations structure element
B(f)	Boundary extraction resultant image
β	Element belongs to the morphological operations structure element
β	Sigmoid function constant
σ_g	Image standard deviation at gray level g
f(*m, n)*	Digital input image
$f(m,n)_{min}$	Smallest intensity value in the digital image
$f(m,n)_{max}$	Largest intensity value in the digital image
g	Gray level value
g(m, n)	Digital output image
$\bar{g}$	Image mean value
H(g)	Image histogram at gray level g
k	No. of non-zero histogram component
L	No. of gray levels in the image
L(i)	Left limitation
M	No. of rows in the image
MAX	Maximum gray level value
MIN	Minimum gray level value
M_T	Total no. of pixels in the image
N	No. of columns in the image
N(g)	No. of pixels at gray level g
P(g)	Histogram probability at gray level g
R(i)	Right limitation
RF_s	Region filling current step
RF_{s-1}	Region filling bravoes step
S1	Sobal operator row mask result
S2	Sobal operator rcolumn mask result

T	Thresholding value
T(g)	Gray level grouping transformation function of gray level g
∩	Intersection
⊕	Dilation process
⊖	Erosion process
⊆	Inclusion
∈	Belonging

الخلاصة:-

يُهدّفُ هذا البحثِ لتَحسين تباين الجزء المرغوب آلياً في الصورةِ للحُصُول على المعلوماتِ المطلوبةِ بدون تَحسين تباين لكل أجزاء الصورةِ. وبكلمة أخرى، تحسيّنُ التباين في المنطقةِ المرغوبة.يَشْملُ النظامَ المُقتَرَحَ لهذا العملِ نظامين فرعيين رئيسيينِ وهما نظام الأستقطاع و نظام تحسين تباين الجزء المقطوع.ينقسم نظام الأستقطاع إلى نوعين، أستقطاع منتظم و غير منتظم. في هذا النظام الفرعي، أذ تُستَعملُ العديد مِنْ التقنياتِ لأستقطاع الجزء الهدف، وهي thresholding، smoothing، boundary extraction، chain code، و region filling. النظام الفرعي الثاني هو تحسين تباين الجزء المقطوع. تم أستعمال خمسة تقنيات الية لتحسين تباين الصورة المقطوعة وهي histogram equalization، gray level grouping، fast gray level grouping، autocontrast و histogram stretching. إنّ الخطوةَ النهائيةَ للنظامِ المُقتَرَحِ هي أعادة أدخال الجزء المقطوع الى الصورة الأصلية. تم تطبيق النظام المقترح على الصور الرصاصية و على الصور الملونة (RGB).